REMARKS

Administrative Overview

Claims 56-67 and 69-75 were examined in the Office action of February 17, 2010, and are pending.

Applicants note with appreciation the withdrawal, in light of Applicants' remarks, of the claim rejections under 35 U.S.C. 103 over U.S. Publication No. 2002/0154132 (**Dumesny**) in view of "Seamless texture mapping of subdivision surfaces by model pelting and texture blending," SIGGRAPH 2000, New York, NY, pp. 471-478, ISBN: 1-58113-208-5 (**Piponi**), and further in view of U.S. Patent No. 6,707,458 (**Leather**).

The Examiner has issued a new rejection of the independent claims 56 and 70, and associated dependent claims 57, 65-67, 69, and 71-75, under 35 U.S.C. 103 over **Dumesny** in view of U.S. Patent 6,131,097 (**Peurach**). Further, the Examiner has rejected dependent claims 58-64 over **Dumesny** in view of **Peurach** and **Leather**.

Without acquiescing to the new rejection, Applicants have amended claims 56 and 70, without prejudice, to recite a mapping scheme wherein points of a planar mesh are adjusted to account for a spacing of corresponding points <u>within a first patch</u> defined over a user-defined region, wherein the first patch is a NURBS patch. The amendment serves to further clarify the relation between various claim elements. Support for the claim amendment can be found in the specification as originally filed, at least in paragraphs [0017]-[0022] of the application as published.

Upon entry of this paper, claims 56-67 and 69-75 will still be pending.

Interview Summary

The undersigned thanks the Examiner for his time and courtesy during the telephonic interview that took place on April 8, 2010. The undersigned notes that the discussion focused on the claim amendments and arguments presented herein. Accordingly, this paper is intended to constitute a proper recordation of the interview in accordance with MPEP § 713.04, and also to provide a full response to the Office Action mailed on February 17, 2010.

The cited art does not teach all of the elements recited in amended independent claims 56 and 70.

Applicants respectfully traverse the rejections of claims 56 and 70 and their dependent claims over the combination of **Dumesny** and **Peurach**. The references, whether alone or in combination, fail to teach at least the following two elements of Applicants' independent claims 56 and 70:

- steps of or instructions for defining a NURBS patch over an arbitrarily-shaped user-defined region of a surface of a three-dimensional virtual object, and using the NURBS patch in a texture mapping scheme wherein points of a planar mesh are adjusted to account for a spacing of corresponding points within the NURBS patch; and
- a mapping scheme that models points of the planar mesh as connected by mechanical modeling elements, wherein the points of the planar mesh are adjusted to reduce an energy associated with the modeling elements.

The references also fail to teach the combination of the above two elements.

1. The cited art does not teach representing an arbitrarily-shaped user-defined region of a surface of a virtual object using a NURBS patch and using the NURBS patch for texture mapping in the manner recited in each of independent claims 56 and 70.

Amended independent claims 56 and 70 recite, respectively, steps of and instructions for defining a NURBS patch over an arbitrarily-shaped, user-defined region, and using the NURBS patch in a texture mapping scheme wherein points of a planar mesh are adjusted to account for a spacing of corresponding points within the NURBS patch. **Dumesny**, which is cited by the Examiner for this claim element, does not teach the use of a NURBS patch at all, let alone the use of a NURBS patch in the manner recited by Applicants' claims. In particular, **Dumesny** models the surface of a three-dimensional object with a polygon mesh for purposes of texture mapping. *See, e.g.*, paragraphs [0011]-[0015].

Applicants previously argued, in their response filed on January 27, 2010, to the Office Action of July 27, 2009, that the use of a NURBS patch for texture mapping lends patentable weight to Applicants' claimed invention, and the Examiner has found these arguments persuasive. *See* Office Action, Response to Arguments on p. 11.

As Applicants pointed out previously, NURBS patches are, throughout the specification, the predominant example used to illustrate the application of Applicants' texture mapping method and apparatus. *See, e.g.,* paragraphs [0020], [0031], [0035]-[0036], [0105]-[0106], [0108]-[0110], [0123]-[0127], and [0132]-[0133] of the application as published, as well as FIGS. 3A-3B, 5, 6, 7B, 9, 18A-18B, 19A-19B, 21A-21C, 23A-23C, 24A-24B, and 26A-26C, which illustrate methods and apparatus using NURBS patches.

Representing an arbitrarily-shaped, user-defined surface region of a three-dimensional object with a NURBS patch is found to be advantageous because it inherently provides more flexibility in modeling the three-dimensional surface. For example, the boundaries of a NURBS patch need not be straight line segments, but may have variable curvature. *See, e.g.,* paragraph [0022] of the specification, as well as FIGS. 3A-3B. Furthermore, the area of a NURBS patch

may have variable curvature in three-dimensional space (*see, e.g.*, FIGS. 18A-18B of the specification), whereas a polygonal representation necessarily consists of planar segments. Thus, NURBS patches afford the user greater flexibility in defining the surface region to which a texture will be applied, and facilitate a more robust, smoother fit to the surface region that is being modeled. Moreover, NURBS patches can represent any analytically definable surface exactly. *See, e.g.,* paragraph [0110] of the specification.

Previous texture mapping methods did not use NURBS patches in the way recited by Applicants, and were not able to achieve these advantages. For example, **Dumesny** relies on modeling the surface of the three-dimensional object with a plurality of polygons, mapping texture onto the polygons using predetermined standard mapping functions (e.g., a standard plane mapping function), and facilitating manipulation (e.g., scaling, rotation) of the texture in user-selected sets of polygons, e.g., to correct for any texture mapping artifacts. *See, e.g.*, **Dumesny**, paragraphs [0011]-[0016]. (*Also see* **Dumesny**, paragraphs [0034] and [0038]-[0041], for a description of artifacts that are typically associated with the application of standard mapping functions to arbitrary, non-primitive surface topologies.) Further, a polygonal mesh will only approximate a curved surface, and the accuracy of the polygonal representation can only be increased by increasing the resolution of the polygonal mesh, thereby increasing the associated computational cost.

Advantages of the use of NURBS patches in the recited method and apparatus are described, for example, in paragraph [0105] of the specification, reproduced below:

> In order to define a surface patch over a user-defined region of the surface of a 3D voxel-based model, a curve loop enclosing the user-defined surface may be divided into four boundary curves, which are used to generate a 4-sided NURBS patch whose interior approximates the surface of the voxel-based model and whose outer edges exactly match the four boundary curves. A NURBS patch is useful because it *relates (u,v) parameter space to a Cartesian space*, because it can be tessellated to any desired resolution, and because it *provides surface normal vectors at any point of the patch.* (Emphasis added.)

NURBS patches map the coordinates (x,y,z) of points on the surface of a three-dimensional object to surface coordinates (u,v) – they parameterize the surface. (For a description of fitting a NURBS patch to a user-defined surface region, *see, e.g.,* paragraphs [0105]-[0110] of the specification.) By contrast, polygonal meshes do not provide such a natural parameterization.

Furthermore, in certain embodiments, Applicants' disclosed texture mapping method involves the use of a second, planar (NURBS) patch that relates the parameters (u,v) of the first, non-planar NURBS patch to the two-dimensional coordinates (s,t) of the texture. *See, e.g.,* paragraph [0030] of the specification. The first and second patch together facilitate mapping the two-dimensional texture coordinates to the three-dimensional coordinates of the surface of the three-dimensional virtual object. Specifically, points of a planar mesh created in the second patch may be adjusted to account for a spacing of corresponding points within the first patch. *See, e.g.*, paragraphs [0017]-[0018] of the specification. Thus, Applicants' method does not require planar

projection (or other standard projection) of the texture onto the surface. In **Dumesny**, however, the texture is mapped onto the polygonal model by piece-wise standard (e.g., planar) projection. *See, e.g.*, **Dumesny**, paragraph [0011]-[0013].

Moreover, the use of NURBS patches is also advantageous in connection with Applicants' graphical user interface element ("widget") for adjusting the texture, as described in the patent application ("[a NURBS patch] provides surface normal vectors at any point of the patch", paragraph [0105]). An advantageous feature of the user interface widget is that one axis of the widget is normal to the surface of the three-dimensional virtual object. *See, e.g.* paragraphs [0139]-[0144] and FIGS. 18A-18B and 19A-19B. As pointed out in the instant application, surface normal vectors exist at any point of a NURBS patch that represents a user-defined surface region. In contrast, surface normal vectors are undefined on the edges of a polygonal mesh approximating the surface. This problem which is associated with polygonal meshes is more pronounced the finer the resolution of the mesh – and, keep in mind, such finer resolution becomes necessary for enabling accurate texture mapping for arbitrarily-shaped, user-defined regions.

In light of the foregoing, Applicants submit that the use of a NURBS patch as recited in the instant claims patentably distinguishes the claimed invention from **Dumesny,** which is limited to polygonal models of surfaces of three-dimensional objects.

Further, neither **Peurach**, which was cited by the Examiner with regard to another claim element (the modeling of points of the planar mesh as connected by mechanical modeling elements), nor **Leather**, which was cited with regard to various dependent claims, cures this deficiency. **Peurach** is directed to authoring geometrical databases that incorporate touch or haptic feedback, and appears to mention texture mapping only in passing (*see, e.g.,* col. 9, lines 1-2). **Peurach** does not appear to be concerned, in any way, with the particular methods that accomplish texture mapping. **Leather** describes texture tiling methods that minimize the conspicuousness of repeating patterns (*see, e.g.*, abstract), but, likewise, does not appear to go into any detail on how to map a texture tile onto an arbitrarily shaped surface, let alone how to employ NURBS patches for texture mapping. Thus, neither **Peurach** nor **Leather** teaches or suggests the use of NURBS patches in a texture mapping scheme as recited in Applicants' claims 56 and 70.

Applicants note that this argument closely parallels the argument previously made regarding the rejection over **Dumesny**, **Piponi**, and **Leather**, which argument persuaded the Examiner to withdraw the previous rejection. More particularly, the previous argument is not substantively affected by the Examiner's citing of **Peurach** as a new reference. Accordingly, Applicants respectfully request that the Examiner withdraw the new rejection consistent with the withdrawal of the previous rejection.

<u>2. The cited art does not teach a mapping scheme that models points of a planar mesh as connected by mechanical modeling elements and reduces an energy associated therewith, as recited in each of independent claims 56 and 70.</u>

Independent claims 56 and 70 each recite a mapping scheme wherein points of a planar mesh are adjusted to improve a quality metric associated with the spacing of corresponding points in a NURBS patched defined over a user-defined region of a three-dimensional virtual object, and

wherein a plurality of points of the planar mesh are modeled as connected by mechanical modeling elements and the points of the planar mesh are adjusted to reduce an energy associated with the mechanical modeling elements. **Peurach**, which is cited by the Examiner for this claim element, fails to teach or suggest the use of mechanical modeling elements in this manner.

Peurach appears to be directed to system and methods for authoring geometrical databases that define virtual objects in term of not only their visual, but also their haptic and other physical attributes, which may affect the haptic feedback that a user feels when encountering the virtual object in virtual three-dimensional space through his avatar. *See, e.g.*, **Peurach**, col. 2, lines 10-19, and col. 3, line 29 through col. 4, line 16. In **Peurach**, physical attributes and features, such as, e.g., classic spring and damper representations, refer to the actual attributes of the virtual object. *See, e.g.*, Peurach, col. 10, line 58 through col. 11, line 56.

By contrast, the mechanical modeling elements in Applicants' claimed invention do not represent the physical properties of the virtual object, but serve as physically intuitive means for adjusting a texture (e.g., a pattern, color, or other visual attribute) that is to be mapped onto the surface of the virtual object. Applicants' mapping scheme is described, for example, in paragraphs [0017]-[0018] of the specification:

> Thus, in one aspect, the invention is drawn to a method for mapping a location on a surface of a 3D virtual object to a corresponding location on a 2D texture including the steps of: selecting a region on the surface of the 3D virtual object; creating a first mesh of points corresponding to points within the selected region; creating a second mesh of points corresponding to points of the first mesh; adjusting the second mesh to improve a quality metric associated with an arrangement of points of the second mesh; relating the adjusted second mesh to the 2D texture; and mapping a location in the selected region to a corresponding location in the texture.
>
> In a preferred embodiment, the first mesh varies in three dimensions according to the surface of the object within the selected region, while the second mesh is a planar mesh. The step of adjusting the second mesh in the method above may further include defining the quality metric using the first mesh. For example, the quality metric may be a measure of total spring energy, where distances between points of the first mesh are used as set lengths for springs connecting points of the second mesh. (Emphasis added.)

Note that the mechanical modeling elements recited in Applicants' claims connect the points of a planar mesh upon which the texture is superimposed, not points on the surface of the three-dimensional object itself. Further, the springs model distances—pure geometric quantities—between points of the first mesh, not any forces associated with the three-dimensional virtual object. **Peurach** does not teach such a texture mapping scheme involving mechanical modeling elements (and the reduction of an energy associated with these modeling elements), as **Peurach** is not concerned with texture mapping methods per se.

For at least these reasons, Applicants respectfully submit that **Peurach** fails to teach a mapping scheme that that models points of a planar mesh as connected by mechanical modeling elements, as recited in independent claims 56 and 70. Further, neither **Dumesny** nor **Leather** cures this deficiency. Therefore, none of **Dumesny**, **Peurach**, and **Leather**, nor any combination thereof, discloses or suggests a texture-mapping scheme using mechanical modeling elements as recited in Applicants' claims.

In light of the foregoing, Applicants' respectfully submit that independent claims 56 and 70 and all their dependent claims are patentable over the combination of **Dumesny**, **Peurach**, and Leather on at least two independent grounds, as they fail to teach at least two claim limitations. Accordingly, Applicants request reconsideration and withdrawal of the rejection, and allowance of the claims in due course. Applicants reserve the right to present further arguments regarding the patentability of the dependent claims, should this become necessary.

CONCLUSION

Applicants contend the claims are in condition for allowance. Applicants respectfully request reconsideration and withdrawal of all rejections, and allowance of claims 56-67 and 69-75 in due course. The Examiner is hereby cordially invited to contact Applicants' undersigned representative by telephone at the number listed below to discuss any outstanding issues.

Respectfully submitted,

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